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CHALLENGES OF MODERN SOCIETY

DISPOSAL OF HAZARDOUS WASTES
PHASE I

FINAL REPORT

No. 77

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16. ABSTRACT

In recognition of the growing importance of hazardous waste generation and disposal to environmental protection and economic development and considering that international cooperation could contribute effectively to a better understanding of the complex nature of the problems involved, the Pilot Study "Disposal of Hazardous Wastes" was originally proposed by the Federal Republic of Germany at the 1973 CCMS Plenary. The proposal was made at a time when numerous environmentally unsound hazardous waste disposal activities were reported in most industrialized countries. There was an obvious need to improve the situation in that area. Governments of nearly all NATO countries recognized this challenge and responded by preparing or reviewing legislation and regulations to control the flow of hazardous wastes into the environment and to avoid further mismanagement. In this respect the proposed pilot study met special interest among NATO allies.

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PHASE I

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Pilot Study "Disposal of Hazardous Wastes"

Final Report

No. 77

I. Overview

1. In recognition of the growing importance of hazardous waste generation and disposal to environmental protection and economic development and considering that international cooperation could contribute effectively to a better understanding of the complex nature of the problems involved, the Pilot Study "Disposal of Hazardous Wastes" was originally proposed by the Federal Republic of Germany at the 1973 Fall CCMS Plenary. The proposal was made at a time when numerous environmentally unsound hazardous waste disposal activities were reported in most industrialized countries. There was an obvious need to improve the situation in that area. Governments of nearly all NATO countries recognized this challenge and responded by preparing or reviewing legislation and regulations to control the flow of hazardous wastes into the environment and to avoid further mismanagement. In this respect the proposed pilot study met special interest among NATO Allies.

2. Based on the results of a Group of Experts meeting convened at Bonn in September 1973, the general objectives of the Pilot Study were defined as follows:

   - to define and analyse technical, organizational and regulatory ways and means for the proper disposal of hazardous wastes

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- to compile and evaluate various management approaches to the solution of the hazardous waste problem
- to draw conclusions from the previous analysis and work out recommendations where possible.

The study was approved under these headings by the NATO Council in November 1973.

3. The Federal Republic of Germany acted as pilot country. The United States and Belgium agreed officially to be copilot countries.

4. The following nine NATO member countries were actively involved in the work-programme of the Pilot Study: Belgium, Canada, Denmark, France, Netherlands, Norway, United Kingdom, United States and Federal Republic of Germany. Italy participated as observer in some expert meetings as did the Commission of the European Communities (EEC), the Organization for Economic Cooperation and Development (OECD) and Japan.

5. In all, seven international expert meetings were held by the Pilot Study Group:

Munich	September 1974
Ottawa	June 1975
London	October 1975 (just Landfill sub-project)
London	October 1975 (just sub-project on Recommended Procedures for Hazardous Waste Management)
Bad Hersfeld	December 1975 (just Underground Disposal sub-project)
Bonn	May 1976
Washington D.C.	May 1977

6. This Pilot Study was not limited to technological and scientific problems as are many other CCMS projects. Basic policy issues of waste management also were discussed as were economic, legislative and regulatory aspects and measures as framework conditions for concrete actions in practice. In this way, the Pilot Study was able to analyse and clarify a great number of complex interrelations between technical and non-technical factors influencing the hazardous waste problem.

7. In the course of 1974 and 1975 the Pilot Study group selected specific problem areas for further discussion and agreed on a well defined working programme. Six individual sub-projects were chosen:

   - landfill research and landfill practice
   - underground disposal
   - transportation
   - organization
   - recommended procedures for hazardous waste management
   - chromium cycle.

   All six of these sub-projects within the Pilot Study are now completed. The sub-project final reports have been printed and are available as official CCMS documents.

8. Each of the sub-projects was essentially implemented as a self-contained effort receiving inputs from different participating countries. Although there was a certain link between some topics of different sub-projects, the work-

programmes of the individual projects were more or less independent from each other. Nevertheless, due to the close cooperation of the members of the pilot study group, conclusions reached in the sub-projects tend basically in the same direction whenever more general questions were addressed.

9. Special emphasis of the work programmes was put on gathering information on the state-of-the art in NATO-member countries with regard to the topics defined. By collating and evaluating this information a broad spectrum of activities and various options in the field of hazardous waste was presented. It is a special merit of the Pilot Study to have considerably improved the mutual knowledge of international developments in the hazardous waste disposal area.

10. It seems important to note that the Pilot Study group faced basic difficulties in making general recommendations in the problem areas dealt with in the Pilot Study. Solutions to the hazardous waste problem depend by nature very much on national peculiarities,e.g. constitutional structures, legal situation, density of population or geological and climatic conditions. These factors vary in part considerably among the participating countries. Moreover, many questions raised within the sub-projects often do not fall under central government responsibilities but have to be decided on a more local level according to the specific circumstances involved. Therefore, the output of the Pilot Study is more characterized by a set of different and flexible alternatives than by uniform recommendations which might be applied everywhere. Just because

of this diversity of suggestions, the results of the pilot study should serve as a valuable tool for practical decision-making in member countries.

11. In order that NATO member countries derive the maximum benefit from the work done within the Pilot Study they should provide for a wide distribution of the subproject reports. This information should reach experts in both government (local and national) and industry. The completed reports should also be offered to other international organisations and bodies like World Health Organization (WHO), Organization for Economic Cooperation and Development (OECD) and to the Commission of the European Communities for further use and circulation.

II. CCMS Resolution on Disposal of Hazardous Wastes

NATO member countries do resolve:

(1) to ensure a wide dissemination of the findings of the sub-project reports of this Pilot Study as indicated in paragraph I.11.above

(2) to pursue the fruitful exchange of information regarding hazardous waste disposal

(3) to consider the conclusions of the Pilot Study projects as guidance to solve the hazardous waste disposal problem

(4) to use their best efforts to implement the specific recommendations resulting from the projects of the Pilot Study

(5) to continue the Pilot Study over the next three years with a Phase II covering the following projects:

- incineration
- surface treatment wastes
- biological chemical and physical treatment
- landfill research

III. Basic Principles for Hazardous Waste Management

The participating countries agreed on the following fundamental concepts and options for an effective and integrated hazardous waste management programme:

Management of hazardous wastes means the organized, systematic channeling of wastes through pathways to assure their recovery or appropriate disposal with acceptable public health and environmental safeguards.

Fundamental to any hazardous waste management planning are attempts to reduce wastes at the source through process changes, material substitutions and modifications in light of appropriate economics. To the extent that wastes are already minimized, separation and concentration of hazardous wastes are often important in order to reduce special handling and management requirements and increase reuse opportunities. Such concentration will occur as air and water pollution control systems remove noxious pollutants from waste streams.

An important option in hazardous waste management is the concept of a hazardous waste clearinghouse, that is, to use the waste as is (if possible). One man's waste can be another man's feedstock. Minor process modifications enhance the possibilities for exchange as well. The clearinghouse concept is already being utilized in more than 13 countries including Austria, Belgium, Canada, France, Netherlands, Norway, Sweden, Switzerland, Denmark, Finland, Federal Republic of Germany, United Kingdom and the United States.

As some hazardous wastes contain valuable basic materials, material recovery makes sense as a next step from both resource conservation and environmental viewpoints. As material shortages become more widespread, material recovery from hazardous wastes will become more economically attractive.

If the hazardous wastes cannot be used or materials recovered from them and if they can be safely burned, destruction by incineration with energy recovery would be a desired alternative with due consideration for residual disposal. Traditional land-based incineration as well as shipboard combustion of wastes are options considered viable in several countries. Nonburnable wastes should be detoxified and neutralized by physical, chemical, or biological treatment, again when necessary and feasible, to reduce special handling and management requirements and minimize the amounts of hazardous materials destined for land disposal. The need for such treatment may be a function of economic constraints and local conditions, such as the availability of suitable landfill sites, in certain countries.

Controlled landfill forms an essential element in the overall disposal strategy. For hazardous wastes disposed of by landfill volume reduction to minimize land use requirements and to facilitate disposal may be desirable. Isolation techniques (such as encapsulation) may be necessary prior to land burial in specially designated landfills in order to assure environmental integrity of the landfill site.

Some countries find that the use of mines (isolated underground areas) can be a reasonable disposal option for selected wastes.

Each country has a somewhat different view as to the emphasis to be placed on any of the succession of disposal options. Also the options should be considered in the light of the quantity and concentration as well as the type of the waste.

IV. Summary, Conclusions and Recommendations of the Sub-Projects

The six sub-projects of the Pilot Study dealt with a number of central problems of hazardous waste disposal. The following sections of this final report contain brief summaries of the work which has been done and the main conclusions and recommendations derived within the individual projects.

A. Landfill Project

(a) Lead Country: United Kingdom

(b) Participating Countries: Belgium, Canada, Denmark, Federal Republic of Germany, France, Netherlands, Norway, United Kingdom and United States

(c) The project dealt with two main topics

- landfill practice and
- landfill research

including the extent to which hazardous wastes are disposed of by landfill. The objective of the work programme was to assess the contribution that sanitary landfill and special chemical landfill can make to the safe disposal of hazardous wastes, with primary regard to the prevention of both ground and surface water pollution hazards, but also of air pollution. As a result more information was submitted concerning the water pollution aspects than on air contamination.

Conclusions

1. The extent to which landfill and special chemical landfill of hazardous wastes is practised in participating countries varies, but in general at present it represents an important method of disposal in almost all of the countries, and this situation is likely to continue for the foreseeable future.

2. In the countries which participated in the project, two main approaches to landfill have been adopted:

a) Landfill is regarded as one of a number of options for waste disposal and forms part of the overall disposal strategy for various wastes including domestic, commercial, industrial and certain types of hazardous wastes.

b) Where restrictions on landfill of chemical or hazardous wastes apply, usually by legislation or because only a limited number of sites are available, there may still be specified exceptions to the limitation.

3. Continued use, for hazardous waste disposal, of landfill and special chemical landfill to some extent by almost all participating countries seems to be a generally accepted principle. Because of the considerable geological, hydrogeological, topographical, climatological and population density differences between the participating countries, it may not be possible to devise a single "management" approach to landfill of hazardous wastes for general use.

4. The importance of avoiding harmful effects of landfills is recognized in all participating countries. The most important of the possible effects is generally agreed to be the potential risk of pollution of water resources, and in particular contamination of groundwater.

5. Examples of pollution both of surface and of ground waters due to landfill disposal of hazardous wastes have been reported by several participating countries. Where such incidents have been experienced, they seem usually to have been due to such factors as poor site selection, inadequate supervision, and incorrect methods of operation as well as insufficient knowledge about soil-waste interaction in the underlying strata, rather than to basic unsuitability of landfill as a disposal route.

6. Because of the continuing importance of environmental protection measures in addition to the need to dispose of wastes safely to land, several countries have in recent years commenced extensive programmes of research into various aspects of landfill disposal. Such programmes are by nature fairly long-term studies, and it has not been possible within the time-scale of this project to examine the final conclusions of the various national programmes currently in progress. However, the project has provided opportunities for useful exchange of information on landfill research topics, and it has been possible to include in the project report some of the preliminary findings from the research programmes of several participating countries.

7. The wide range of topics and methods included in landfill research programmes are intended to provide the responsible authorities in each country with the guidance needed to develop future waste disposal policies, and to assist in defining the relevant legislative measures. From the large number of individual topics being investigated, it is possible to define three main areas of interest:

   a) How to minimise the leachate generating potential of wastes, and control the movement of any leachates that are produced within the landfill, and to study factors affecting movement of leachates away from the landfill.

   b) How to select suitable sites for landfills, with regard to geological, hydrogeological and other relevant parameters.

c) What are the best methods for landfilling wastes of a particular type at a given site, including the extent to which co-disposal of different wastes can be used.

8. In most current investigations, the main objective appears to be the understanding of the processes governing movement of leachates at existing sites. When further information from field observation and laboratory studies is available, it may then increasingly be possible to make predictions relevant both to those sites and to other sites for which some basic data is available. Already, however, there is substantial evidence from preliminary results of field investigations and laboratory/lysimeter research work to support the view based on experience that significant attenuation, retention and recovery mechanisms apply, particularly when systems are not overloaded.

9. A supporting approach to the study of leachate generating potential consists of developing standard leaching procedures which can be applied to the testing of wastes before they are landfilled. Standard leaching test procedures are currently being studied by several member countries, but it seems likely that the nature, purpose, and status of these procedures, when details are finalized, may differ considerable between countries.

10. In connection with the selection of sites for use as landfills, application of the findings of research investigations is already being made in participating countries, and site selection criteria are being developed for use by authorities responsible for waste disposal. At present, two main approaches seem to be used for selection of sites

a) Sites selected on the basis of their ability to contain wastes and leachates, especially from hazardous materials,

b) Sites which do not rely on containment, but which permit natural processes both within and outside the site to attenuate and disperse contaminants and to reduce concentrations of leachate components.

11. Preliminary research results from the various programmes described in the sub-project report, together with experience from many existing sites, suggest that the "attenuate and disperse" principle may in some cases have advantages on environmental and technical grounds to the "containment" approach. Nevertheless some countries still have substantial reservations about attenuation and similar effects and tend towards leachate containment, collection and treatment. Further results obtained from landfill research programmes will permit more detailed guidance on site selection to be provided, so that whichever approach is adopted, the risk of selection of unsuitable sites should be eliminated.

12. Methods of disposing of particular wastes at landfill sites, and site operational techniques in general, have not yet been studied systematically during investigations, but a few projects are currently in progress in member countries. Of particular importance is the extent to which co-disposal of domestic and industrial (including certain types of hazardous) wastes is applicable. At present, co-disposal is not practised in some countries, but in others it is used to varying degrees and in some is being extended. Co-disposal would not be appropriate for wastes with considerable recovery potential, nor for particularly hazardous wastes which might endanger public safety and the environment, but for a wide range of other wastes, there is in fact considerable scope for co-disposal in landfills.

13. The results of both experience and research work stress the importance of correct operating procedures at landfill sites. The maintenance of a satisfactory balance between liquid and solid wastes is important if use is intended to be made of the absorptive capacity of the latter.

Recommendations:

1. It is considered that, for the future, attention should be paid in particular to continued work on

   a) operating procedures for the landfill of hazardous wastes, including air contamination aspects,

   b) the field-study of recovery and attenuation mechanisms in existing landfill sites,

   c) the smaller-scale research work on the interactions of hazardous wastes and leachates with domestic waste, and with various soils and rocks, and

   c) site selection and engineering criteria.

2. The results of landfill research which is finished, still in hand or planned should be made available for the information of all member countries.

B. Underground Disposal Project

(a) Lead Country: Belgium

(b) Participating countries: Belgium, Canada, Denmark, Federal Republic of Germany, France, Netherlands, Norway, United Kingdom, United States.

(c) The project focused on the analysis and the determination of the technical and economic circumstances and conditions under which hazardous wastes can be safely disposed of in inactive or partially active mines. Particular importance was assigned to the problem of avoiding any water pollution.

The project summarizes the geological criteria and operational requirements which should be fulfilled as necessary prerequisites for underground disposal of hazardous wastes. Various mineralogical formations are described and evaluated with respect to ensuring permanent environmentally-sound storage of hazardous wastes. On the basis of a detailed analysis, a classification scheme is proposed for decision-makers ranking individual mineralogical formations with respect to their suitability for underground disposal.

In a second step, the nature and composition of hazardous wastes are investigated which are most suited for underground disposal. Based on an analysis of the possible interactions of the wastes with the surrounding mineralogical environment, general criteria are given which have to be considered when selecting hazardous wastes for underground disposal.

Finally, the project evaluates those two practical applications of the underground disposal method which up to now have been realized in NATO-member countries. In the Federal Republic of Germany, an active salt mine provides particularly favourable conditions for the underground disposal of selected solid hazardous wastes. The second example described deals with an old coal mine in the United Kingdom which since 1965 has been used for the disposal of certain liquid hazardous wastes.

Conclusions

1. An inactive mine which meets the geological and technical criteria defined by the project, constitutes the most acceptable solution for the underground disposal of solid hazardous materials. However, a mine with both active and inactive sections can be used for a double purpose at the same time: for exploiting a deposit and for disposing of hazardous materials.

2. Salt mines and potash mines seem to be the most adequate for the underground disposal of solid hazardous wastes. It is expected that in the near future the underground disposal method will be limited to salt mines.

3. The underground disposal of hazardous wastes should be authorized only under the conditions that it does not involve noxious effects for the biosphere and for the extraction of minerals or subterranean water.

4. The underground disposal method can be considered as a solution only for categories of waste materials whose production is inevitable and whose recycling, regeneration or any other method of elimination is not economically feasible with the existing techniques. Research on these alternative methods remains very necessary.

5. In summary, it is well to accept underground storing only when carried out under the strict technical conditions explained in the project. Moreover, it would be well to strengthen the requirements still further if some danger were to arise about which one does not know enough at the present time.

6. The underground disposal of liquid wastes seems to be possible only in very few particular cases where a considerable number of favourable criteria must be assembled. The principal attitude to adopt for liquid wastes should be based on the recognition that until now one has only a limited understanding of the possible effects on the receiving mineralogical structures.

C. Transportation Project

(a) Lead country: United States

(b) Participating countries: Canada, Federal Republic of Germany, France, United Kingdom, United States

(c) This project addressed problems involving the transport of mixtures of hazardous substances as they occur in the form of hazardous wastes. In particular it was considered whether the current rules and practices for the transport of pure hazardous substances or goods do or do not provide adequate public health, safety and protection to the environment from the potential effects of hazardous wastes. Primarily this examination was undertaken by making reference to the United Nations Recommendations on the Transport of Dangerous Goods.
Transport in the sense of the project was understood as the actual shipment of materials requiring certain provisions for packaging, marking and labeling, vehicle placarding and vehicle and equipment standards. The different aspect of control of transport as part of the disposal route of hazardous wastes was dealt with in the sub-project on "Organization".

The transportation experts concentrated on the following two main issues:

- how to classify hazardous wastes in terms of the U.N. classification scheme for dangerous goods

- whether and how to take account of the long-term, i.e. chronic hazards of hazardous wastes in future U.N. Recommendations on the Transport of Dangerous Goods. Until now these recommendations generally consider only acute hazards in transport.

With regard to the classification problem, different lists of hazardous compounds and hazardous wastes were submitted by the Pilot Study group and analyzed by the transport experts. A large portion of the listed hazardous wastes which were characterized by one or two constituents could be generally associated with existing U.N. classification classes because of their acute hazards. The United Kingdom and the Federal Republic of Germany each proposed a classification scheme that would also be applicable to more complex mixtures of substances which occur as wastes.

Conclusions

1. With regard to transport, a large proportion of hazardous can be characterized in a simplified approach by one or two components constituting an acute hazard in transport in terms of either flammability, explosivity, toxicity or corrosivity. These wastes can be associated with the existing U.N. classes (for transport) without major difficulties.

2. However, for a certain portion of hazardous wastes, in particular, when they contain a mixture of many substances, attempts to solve the classification problem are still in a preliminary stage. Common criteria for tackling this problem have not yet been developed in NATO member countries.

This complex subject requires close cooperation between transportation and waste management experts in the near future.

3. Some hazardous compounds and hazardous wastes analyzed in the project had to be classified in the UN class "Miscellaneous Dangerous Substances". These wastes need a more specified classification in the future.

4. Long-term environmental effects of hazardous materials are generally not considered in the current transportation rules. Existing labeling requirements seem to be insufficient for giving advice to cover environmental aspects, e.g. the prevention of water pollution by spillages.

5. The lack of criteria makes the establishment of a transport classification scheme for hazardous wastes with chronic effects more difficult than for wastes of the acute type.

Recommendations

1. The producer, shipper or any subsequent shipper of hazardous wastes should be responsible for selection of the packaging, labelling, placarding and vehicle equipment. The producers/shippers must clearly indicate to the transporter on the shipping paper (manifest) the information required to transport the hazardous waste to the disposer, including the composition of the hazardous wastes, as well as attaching to the shipping paper information necessary to prevent spills from endangering health or the environment in the event of an accident.

2. The U.N. Committee of Experts on the Transport of Dangerous Goods should be asked to establish a new classification scheme for those hazardous wastes which do not meet existing U.N. criteria. Several options which could be considered are:

   a) New divisions under U.N. Classes 3, 6 and 8 i.e., Division 3.4 for flammables; Division 6.3 for poisonous (toxic) substances; and Group IV for corrosives under Class 8.

   b) Establishment of a new division for hazardous wastes in U.N. Class 9 (Miscellaneous Dangerous Substances).

   c) Creation of a new U.N. Class 10 entitled: "Environmentally Hazardous Substances" for those wastes hazardous to health or the environment, but which do not meet existing U.N. criteria for the transport of dangerous goods.

3. The U.N. should be asked to develop a classification scheme for the transport of mixtures of hazardous wastes taking thereby into consideration the proposals of the Federal Republic of Germany and the United Kingdom, which were submitted to the project. Therefore, copies of both proposals should be forwarded to the U.N. Committee of Experts on the Transport of Dangerous Goods.

4. The Organization for Economic Development and Cooperation (OECD) should be asked to furnish the UN with classification criteria for the waste substances submitted by the Pilot Study group so that these substances can be made subject to U.N. Recommendations for the Transport of non-acute hazardous wastes, in particular concerning labelling.

5. Hazardous wastes of a chronic nature which might pose a hazard for health or the environment, but which do not meet the U.N. classification criteria for dangerous goods, should be considered subject to shipping paper and marking requirements so that the wastes can be controlled from producer to disposer, including requirements for handling spills due to accidents.

6. Divergent approaches by different international organizations to the environment problems occurring in transport of hazardous wastes should be avoided.

D. Organization Project

(a) Lead country: Federal Republic of Germany

(b) Participating countries: Belgium, Denmark, Federal Republic of Germany, France, Netherlands, United Kingdom and United States of America.

(c) The project aimed at a survey and an evaluation of organizational and legislative measures in the field of hazardous waste management in participating NATO countries. The effort undertaken particularly addressed problems of control, planning and organizational execution of hazardous waste disposal. It covered not only questions falling under governmental responsibilities but also included respective actions in the private sector.

The project concentrated on the following aspects:

(1) Legislative basis of organization of hazardous waste disposal, e.g. discussing

- regulations on control of waste flows

- regulations on licensing of disposal facilities

- planning regulations

- regulations on particular forms of organization

- regulations on liability, financing and insurance

(2) Practical application of existing regulations to (1)

(3) Developments, which take place by private initiatives, e.g. waste exchange systems

(4) Evaluation of advantages and disadvantages of different organizational schemes with special regard to general waste disposal policies in participating countries.

The information necessary for reaching the project objectives was obtained from replies to detailed questionnaires circulated to the NATO countries and discussion at the expert meetings.

Conclusions

1. The possibilities of establishing certain organizational forms for the disposal of hazardous wastes have to consider the constitution, the legal system and the political objectives of the country concerned.

2. Adequate waste disposal requirements (standards) on a national level are of importance for the organization of hazardous waste disposal. Such standards would, for example, facilitate control measures such as licensing of facilities, and help to improve planning as well as financing.

3. The organization of disposal of hazardous waste will often be improved by disposal facilities with a large capability.

4. The control of transport processes is of special importance.

5. The disposal of hazardous wastes and the operation of disposal facilities is not in principle the responsibility of the central or local government; the waste-generating industry as well as private enterprises have to take over important tasks in this field.

6. Even if waste disposal is organized on a private basis, it may be necessary for government - owned, government-controlled or joint facilities to be available, if capacity of the private system proves to be inadequate.

7. The classification of hazardous wastes is of importance for the organization of their disposal as a basis for planning and control.

8. Financing of facilities for the disposal of special wastes constitutes a problem, irrespective of the ownership of these facilities. This problem can be solved by the provision of financing mechanisms. The financing from general budgetary funds only appears justified in exceptional cases.

9. Based on the polluter-pays-principle, the following concepts of financing seem possible:

   - financing by the operator
   - financing by industries, also by joint ventures (industry-owned facilities)
   - financing by public bodies using a fund supplied with payments from waste producers

   or by a combination of the above

10. Private investments for facilities can only be expected when there is a "market" for such facilities and when the use of such facilities is either enforced by legislative measures or acceptable to the waste producers at fees which guarantee a profit for the operator.

11. Legal enforcement of obligatory use of licensed facilities can be regarded as a strong means to encourage financing of facilities out of private sources.

12. From the point of view of liability and safety, the financial responsibility of disposal enterprises is of special importance. These aspects can also be taken into account by imposing the obligation to take out insurance or by other appropriate measures, such as performance bonds.

13. The problems of financing the long-term care of landfill sites for hazardous wastes are still largely unsolved and need further clarification.

Recommendations

1. A harmonization of technical and safety standards for waste disposal on the international level would help international cooperation in this field and should therefore be envisaged.

2. An essential task is the planning of the disposal system. Government authorities have to consider their responsibility in this area. It should be carried out in close liaison between the authorities responsible for the disposal of hazardous wastes, the disposal enterprises and the interested groups from industry and with regard to disposal of other general wastes.

3. The planning of sites for facilities for the disposal of hazardous wastes should at least be undertaken for a fairly wide region. The preparation of individual plans should take account of overall planning requirements.

4. For facilitating disposal of some hazardous wastes in wide areas, the establishment of collection centres should be considered. Due regard has to be given to the fact that the establishment of collection centres might increase overall costs of disposal. Some of the collection centres should be equipped with facilities for pretreatment.

5. The disposal of hazardous wastes requires controls by government authorities. Controls should extend to the licensing and verification of facilities and to the disposal route of the wastes.

6. The method of implementation of legislative measures on control issues has to relate to whether organization is carried out by private enterprise or by public bodies, i.e. external control by legislation measures will have to be more formal in case of private initiative organizations whereas control of public bodies should be obtainable by means of internal control.

7. When licences for waste disposal facilities are granted, the restoration and stabilization of the utilized terrain after closing of the facility should be provided for by appropriate measures. As much as possible the costs of restoration or stabilisation should not to be borne by the public.

8. Among the possible measures for the control of the disposal of wastes, controls at the source (i.e. control of waste generation) should be given priority.

9. Waste exchanges are an effective organizational means to increase the utilization of industrial residues. Their establishment, maintenance and effectiveness should be encouraged by appropriate measures. Any direct government involvement with the organization and operation of waste exchanges must take appropriate regard of confidentiality aspects.

10. Financing is strongly linked to legislation on forms of organization, (i.a. ownership of facilities), areal coverage of facilities and on control measures. It has thus to be borne in mind that these conditions must fit into the concept of financing.

11. Taking into consideration an organizational scheme based on facilities run by public bodies due regard should be paid to the polluter-pays-principle.

12. The prices charged for the disposal of hazardous wastes should be based on the disposal costs including investment amortization and long term care. Where appropriate to the particular country's attitude, possibilities to achieve equal price levels should be explored in order to compensate for site disadvantages.

13. Subsidized disposal prices should only be envisaged in strictly limited cases, for example, to introduce new technologies or for research purposes. The possibilities to grant low-interest loans for investments however should be investigated.

14. Where appropriate to the particular country's attitude, the costs of transport from the collection centres to the disposal facilities should be included in the disposal costs in order to avoid site disadvantages and to equalize disposal costs. To avoid restrictions in the field of transfrontier waste transport and disposal, reasonably uniform requirements should be envisaged in the different countries.

15. Sites of a particularly favourable nature should be (also internationally) made available not regarding the origin of wastes - but with due regard to the cooperative principle. This requires close cooperation of state authorities both on a national and international level. Limitations of capacity and the avoidance of unnecessary long transportation of the wastes have to be taken into consideration.

E. Project on Recommended Procedures for Hazardous Waste Management

(a) Lead countries: United States/Canada

(b) Participating countries: Canada, Denmark, Federal Republic of Germany, France, Netherlands, United Kingdom, United States

Contributions to the project were also made by the Commission of the European Communities.

(c) The project addressed the following topics:

(1) Definition and classification of hazardous wastes

(2) Waste sampling and analysis

(3) Site selection (including citizen acceptance)

(4) Long-term care of hazardous waste disposal facilities

(5) Permit processes

(6) Labeling

(7) Facility safety

The United States led topics (1) - (4), while Canada coordinated the work on topics (5) - (7).

In summary, the project on "Recommended Procedures for Hazardous Waste Management" focused on implementation issues that arise from consideration of the options for an integrated hazardous waste management programme. The topics group themselves around two themes: the identification of hazardous wastes and the authorization for operation of hazardous waste disposal facilities.

In the first place the project concentrated on an international comparison of alternatives either realized or planned with respect to the addressed problems. Because of the wide spectrum of different approaches in NATO countries the project did not result in definite recommendations. But comparisons and contrasts between concepts utilized by participating countries do provide useful insights and information for those who are interested in the problem areas.

Conclusions

1. Central to any programme to manage hazardous waste are the definition limits on those waste materials controlled by the management system. These definitions are designed to suit the nature of the environmental problem to be solved as well as the socio-political and economic conditions existing in each country. Harmful effects as the result of a disposal act are in general the major criteria for statutory definitions.

2. There are basically two regulatory approaches for establishing a country's classification of hazardous waste: the list approach (enumeration of types of wastes) and the criteria approach.

3. Current hazardous waste lists are generally in a developmental stage of preparation. Although the methodologies differ to establish such lists a considerable international consensus exists regarding which materials should be classified as hazardous under disposal aspects.

4. Due to basic differences in hazardous waste management technology, political and economic structures of the various countries and the present lack of information on the properties of many wastes an international hazardous waste list seems not yet feasible.

5. Techniques for sampling and analysing waste streams are essential to identify hazardous wastes. There is an obvious need for standardized sampling and analysis procedures. Different waste types may well require different procedures.

6. There are usable, inexpensive techniques for analysing for most inorganic wastes of concern, especially heavy metals; the interferences involved in these techniques are understood to an extent and difficulties in that area can often be solved by pretreatment.

7. The problem of waste analysis is far from being solved. The large number of potential constituents, their differing properties, the wide range of concentrations in which they may be present, as well as many mutual interactions between constituents make the problem of developing standard methods exceedingly complex.

8. Complications with pretreatment of samples and separation techniques make results from sampling and analysis often difficult to interpret. It is obvious that much work needs to be done in both areas.

9. Careful site selection for safe disposal of hazardous wastes is one of the most important first steps for controlling the long-term effects of the hazardous properties of the discarded materials.

10. Approaches to site selection of disposal facilities are generally in a developing stage in NATO member countries. There are still few examples where site selection processes have been formalized using some type of a systematic plan, e.g. a matrix or a decision tree.

11. Among site selection criteria soil characteristics and groundwater conditions are the physical factors of greatest concern.

12. Site selection processes needclose cooperation between competent authorities and experts on geology and hydrology.

13. The aspect of citizen acceptance is of increasing importance for site selection of hazardous waste disposal facilities. This acceptance often needs carefully prepared education and information campaigns.

14. Mechanisms for long-term care are still being developed as essential elements in a comprehensive system for hazardous waste disposal.

15. A rather common approach in NATO countries is to provide for (long-term) safe sites via more or less comprehensive licensing systems. The United States is considering, in addition, to require financial arrangements by the owner in order to provide money for long-term care and monitoring of disposal sites or for closing them down, if necessary. Comprehensive provisions for long-term care will necessarily include both of these provisions.

16. It is necessary that decisions relative to waste disposal be reviewed at all stages of production and handling. Decisions prior to production are also very important.

17. Disposal facility performance permits are necessary to control

- facility safety and capacity
- waste products allowed for disposal
- disposal methods to be used for specific waste
- effluent and emission criteria
- record of wastes disposed of (particularly for land disposition of hazardous wastes for long-term control).

18. The identity of hazardous wastes must be maintained from production to ultimate disposal and decisions in hazardous waste disposal must be controlled. A trip ticket is regarded as a valuable control tool.

19. It is desirable, that the containers of waste products have markings which indicate in some manner the nature and degree of hazard associated with the product, and any special handling and disposal procedures which may be required if the waste is to be handled by second or third parties.

20. Containers of hazardous wastes handled within a facility or leaving that facility should be appropriately labelled. The label should indicate as a minimum

(a) Manufacturer's or producer's name and address

(b) Description of contents

21. The technology and techniques for handling hazardous wastes are essentially the same as handling other hazardous commodities, but the degree of uncertainty is much greater. Therefore, a propertionate increase in safety precautions should be taken at hazardous waste management facilities.

F. Chromium Cycle Project

(a) Lead country: France

(b) Participating country: France

(c) Regarding the problem of chromium pollution, this project was proposed as a self-contained effort by France. It was carried out by commissioning a specific study on the French situation in that area. The primary objective of the study was to obtain better knowledge of the chromium cycle in French industry and of the pollution

involved in the utilization at the various stages of the processing of the mineral, manufacture of the basic products, application of these products and their consumption. At the same time, the various techniques that could be used in solving the problems at issue, in particular those involving water pollution, were investigated in detail.

Although the study confined itself to a presentation of French conditions many results obtained can be easily transposed to other industrialized countries. This holds in particular for the technical elements of the study and the analysis of the environmental impacts of the use of chromium in industry. In this respect the project forms an useful guide for NATO countries to analyse their own situation in this area.

Conclusions

1. Toxic chromium wastes containing substantial quantities of chromium in its hexavalent form are only generated in chemical applications. The major sources are the surface treatment industry and tanneries. Another source of toxic chromium wastes is the use of chromium in catalysts and pigments.

2. In metallurgical processes no toxic chromium wastes are produced. Losses of chromium occur essentially in the form of ores. Losses in slags are also neutral with respect to the environment.

3. In refractory applications chromium is incorporated in the form of insoluble products which are not harmful to the environment.

V. Other Activities

A. Manual on Hazardous Substances in Special Wastes

Parallel to the work within the six sub-projects of the Pilot Study, the Federal Republic of Germany submitted a draft version of an extensive manual called "Hazardous Substances in Special Wastes".

This manual is intended to provide a presentation of those characteristics of hazardous substances that are relevant to wastes. By describing the nature and possible effects of the selected substances on public health and the environment, the manual exhibits the danger potential of the wastes which contain such substances. In addition, the manual offers information on the generation of special wastes and appropriate treatment and disposal methods.

The manual primarily gives assistance to those involved with the problem of special wastes within waste management. A second target group is the scientific sector dealing with "environmental chemicals". Finally, the manual can be used as a source of information by the general public interested in hazardous substances and hazardous waste issues.

B. Report on the Generation and Disposal of Hazardous Wastes in Norway

In a detailed contribution to the Pilot Study Norway gave a survey on its own situation and activities in the area of hazardous waste disposal. The submitted report begins with a survey of the quantity and composition of hazardous waste in Norway. Further information deals with the operation and control of special landfill sites. Finally a description is given of landfill research activities including field studies on specific landfills as well as laboratory investigations.

VI. Publications

The following documents were published within the framework of the Pilot Study (Phase I).

1. CCMS-document No. 52 "Chromium Recycling"
2. CCMS-document No 55 "Manual on Hazardous Substances in Special Wastes"
3. CCMS document No 62 "Recommended Procedures for Hazardous Waste Management"
4. CCMS document No 63 "Organization"
5. CCMS document No 64 "Landfill"
* 6. CCMS document No 68 "Transportation"
* 7. CCMS document No 69 "Underground Disposal"
* 8. CCMS document No 77 "Pilot Study Final Report (Phase I)"

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*) to be inserted after the CCMS plenary session October 18/19, 1977